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ЛВИ НВТ ООО ЯЭМЗ ЯРОСЛАВЛЬ

The cable laboratory LVI HVT-35FAV with 3 phases system of connection to the object

LVI HVT-35FAV is meant for the following:

- Test power cables with paper-oil insulation with operating voltage up to 20kV;
- Test of power cables with cross-linked polyethylene insulation with operating voltage up to 35kV;
- power cable fault locating with the operating voltage 35kV using pinpointing and prelocation.

The laboratory has the following functions:

1.High voltage DC testing with leakage control
2. High voltage testing by very low frequency 0.1Hz
3. Measurement of the isolation's resistance
4. Burning of the power cable's damaged isolation
5. Distance measurement to the fault location in the cable with the help of the impulse method.
6. Distance measurement to the fault location in the cable with the help of Arc Reflection method
7.Fault prelocation by Arc Reflection method during burning down
8.Fault prelocation by the method of fluctuating traveling voltage wave
9.Fault prelocation by impulse current method (method of current traveling wave)
10. Fault location with the help of the acoustic method
11.Fault location and location of the cable route by the inductive method
12. Fault location of the cable sheath
13. Chose of the testing cable from the bunched cables

A. HIGH VOLTAGE TESTS BY RAISED VOLTAGE

1.The main equipment.

The laboratory equipment is usually subdivided into main and additional equipment. Such an arrangement helps to perform the planned addition of the laboratories' functions, so to increase its affectivity.

1.1 Control unit

It is used for the commutation of the laboratory units and blocks on the feed circuits, as well as for lightning and heating control inside the laboratory.

1.2 Voltage regulator

Is used for the sliding control of the feed voltage level, delivered by the BVI-100, BNI-M and IDP-10 blocks. If the regulator isn't at the zero position so the testing process is impossible.

1.3 VI control unit

The high voltage testing control with testing voltage measurement on the high side using the SVN measurement system (certified measuring system, inaccuracy of measurements< 3%)

A.1. High voltage tests by raised dc voltage

1.4 The high voltage testing block BVI-100M

Functions of BVI:

Testings by high DC voltage up to 60 kV of dischargers, cable lines etc. leakage test objects within the range 0,2 mA, 2 mA, 20 mA.

During testings by high DC voltage of dischargers or other objects with small capacity it is used smoothing capacitor with the capacity 0,4uF.

1.4.1. Testing voltage source INN 100/60

The maximum DC testing voltage is 60kV at the maximum current 100 mA

A.2. High voltage tests by raised ac voltage very low frequency 0.1Hz.

1.4.2.The high voltage testing block at the very low frequencies 0.1Hz

While testing the cross-linked polyethylene cable it is more convenient to use the devices generating the ac voltage at the very low frequencies- from 0.1Hz and lower. There is a VLF-6022 installation which is build-in the laboratory. It generates AC voltage at a very low frequency and is intended for field-testing of paper-oil isolated or polyethylene power cables, power transformers, electromotors and other objects with high capacitance. This model with peak output voltage 60 Kvac is for testing cable classes up to 35 Kv. It could be loaded with high capacity for testing cables up to 16 km depending on type.
It has extended sort of possibilities: currentmeter and capacitancemeter and also kilovoltmeter of output voltage, timer of testing and indication of output voltage.

Parameters	Technical description
Input	230V, 50Hz, 8A peak, 4A avg.
Output	0 - 60 kVac peak Selectable, 0.1/ 0.05/0.02Hz, Sinusoidal
Duty	Continuous
Rated Loads	1.1 **u**F/0,1Hz; 2,2 **u**F/0,05 Hz; 5,5 **u**F/0,02 Hz
Measurement Equipment	Kilovoltmeter: Scaled 0-60 kVac peak Currentmeter: Scaled 0-100 mAac peak Capacitancemeter: 0-6uF

B. CABLE FAULT LOCATION

B1. Preliminary cable fault locating.

2. The preliminary fault locating equipment and methods

The reflectometerical method

2.1.High voltage impulse generator GVI 2000M

This generator is used for energy stacking in the high voltage condenser and sending the high voltage pulse of different frequencies to fault locating in the power cables up to 35kV by the acoustic method.

Parameter designation	Value
Power supply voltage	220±22V, 50Hz
Impulse parameters of the wave generator:	
Regulating range of the output voltage	0...5;0…10;0..20 kV

Frequency of the impulse movement	3-15 c
Output voltage stages	5,10, 20 kV
Maximum storage energy	2000J
Consumption current, no more	1,5kVA
Capacitors' value	4 x 40,0 uF
Time period of capacitors connection to the cable line	400 мs
Generator's continuous running time with the following break 1 hour (up to)	1 hour

2.2 Voltage connector

(Decay method)

To determine the distance to the place of complicated (high resistance) or transient fault, when transient resistance in the place of fault is much higher than the wave resistance of line and is commensurable with the value of insulation resistance, it is used a **method of oscillatory discharge (Decay method)**. The method is based on the measurement of half-period time of oscillatory electro-magnetic process, which appears during insulation failure of charged cable and has 2 modifications:

- Method of voltage traveling wave;
- Wave method of pulse current.

To apply the ***method of traveling voltage wave*** together with the source of testing voltage it is used a voltage connector (photo). Voltage connector is a capacitance divider with the division ratio, which provides voltage on wave input of reflectometer not more than 60V.

Pulse reflectometer is connected through the voltage connector. This method can be used for fault location in cables with paper-oil insulation. For cables with XLPE insulation this method is forbidden since application of high DC voltage breaks XLPE cable insulation.

2.3 Current connector

At the ***wave method of pulse current*** surge generator gives pulses to the cable line. It breaks the weak place of insulation, which initiates the reflection. Reflected signal returns to the beginning of cable and is reflected from it to the side of fault since the input resistance of surge generator is equivalent to the short circuit. Re-reflected wave comes to the break and again returns to the beginning of cable etc.

For the purpose of this method it is used a surge generator, current connector, and reflectometer with the possibility of work in the appropriate mode. The current connector is a current transformer which provides signal with the amplitude not more than 60V on the wave input of reflectometer. While applying a method of **oscillatory discharge** the pulse reflectometer is connected to the socket **«U/I»**.

2.4 Reflectometer TDR-107

It is applied to definition of the cable inhomogenuties and any kinds of cable faults.

Structure:

1) TDR-107
2) Measuring cable
3) Software
4) The user's manual

TDR-107 is a modern digital reflectometer. It is specially developed for distance definition to the obstacles locations and any kinds of power cable faults. The reflectometer provides the maximum accuracy of measurements and does not create dangerous surge voltage in cable isolation.

The main features of the reflectometer:

- obstacles distance measurement of wave resistance or fault,
- distance between obstacles measurement of wave resistance of a cable,

• definition of faults character,
• definition of cable length,
• measurement of line shortening factor if the length is known.

The electric arc stabilization method (Arc Reflection)

2.5. The connector AR-20 (for electric arc stabilization).

AR-20 coupler

It is intended for distance locating to the fault by the impulse method (classical) and high voltage method of reflection of the arc (Arc Reflection method). The device can quickly locate the distance to the low-ohmic and even high-ohmic faults in the power cables without burning (in Russia it is so called "without burning method").

B2. Pinpointing cable fault locating

3. The pinpointing fault location equipment and methods.

3.1 Burning installation UP-7M2

Is used for high-ohmic power cable faults 0.4 – 35kV and in low-ohmic to create conditions for:

- distance location to the fault by impulse method,
- pinpointing to the fault by audio-frequency installations.

Parameter designation	**Value**
Power	220±22V, 50/60 Hz
The burning installation parameters:	
1.The current, expended by the installation in "wasted motion" mode no more than	3A
2.Consumption current in short circuit mode, no more than	57A
3.Output voltage of the installation in "wasted motion" mode:	
step (AC± 15%)	0.17 kV
step (AC ± 15%)	0.5 kV
step (AC +15%)	1.4 kV
step (DC+15%)	5.5 kV
step (DC ± 15%)	11 kV
step (DC ± 15%)	22 kV
4.Short circuit current on the installation's output:	
step (AC ± 15%)	64 A
step (AC + 15%)	22 A
step (AC ± 15%)	7.8 A
step (DC + 15%)	2.3 A
step (DC ± 15%)	1.4 A
step (DC+ 15%)	0.7 A
5.Consumption power, no more	12 kVA
6. Continuous work time of the installation in the burning mode (20 min interval), no more	20 min

3.2 Connecting device

Reflectometrical burning method

Laboratory also has ***Arc Reflection Method when the burning is used.*** Usage of this method allows to observe on the reflectometer screen changes in the place of fault during burning and to automatically do the preliminary distance finding to the fault location. The distance is determined by peak discharge voltage in the burning cable since the first stage of burning cable is accompanied by pulse discharges (during burning in the place of fault it is formed an arc).

For application of ***Arc Reflection Method during burning*** the burn down instrument is connected to the cable line through the connector AR-20.

Inductive method

3.3Control unit of the generator IFL-55106

Is used for the cable fault locating by the inductive method.

3.3.1 Inductive Fault Locator Set IFL-55106

Is used for:

- The definition of the location of a route and depth of the buried cable
- The search and exact definition of the place of fault in the cable
- The selection of the cable- a choice of the demanded cable
- The definition of the place of fault of the cable sheath

Generator IFL-55106
Search SR-01 receiver
Induction IP-01 detector
Acoustic AP-01 detector
Induction IP-08 detector
A-framework

3.3.2. Acoustic

Acoustical method

Acoustic AP-01 detector.

C. Measurements

4. Low voltage testing block BNI-M

Is used for low voltage measurements using the external units. It has the build-in source of the smooth regulating voltage 0-220V, 0-380V

C.1. Low voltage measurement

4.1 Low voltage measurement block BNI-M

It is intended for low voltage tests using the external devices.
It has built-in source of continuously adjusted voltage 0-220V, 0-380V.

The laboratory is packed with the standard equipment for the following measurements:
- the transformer ratio (Kt)
- Current measurements (Ixx) and standby loss (ΔPxx) on low voltage
- Short-circuit resistance measurement (Zk)
- Resistance measurements by bridge method
- Insulation resistance measurements
- Ground resistance measurements
- Conductor's current measurement
- Common low-voltage measurements (R, I, U)

D. High voltage commutation and connection techniques

5. Main switch HVS-75/3

High voltage switch HVS-75/3 is applied for choosing phases of testing cable and for commutation of equipment outputs. It is located in the right side of the control panel. HVS-75/3 has input ports for connection of functional modules and output ports for connection of high voltage testing cables of the laboratory. It is also connected with the measuring terminals for connection of different devices. On the main switch there are switches which automatically contact high voltage output to «ground» after the job is finished. It has manual control and air barrier insulation.

5.1 Cable drums blocks

External accessing of laboratory provided by the drum with the power cable, grounding cable and high voltage cable. The high voltage cable length in the drum is 25 m.

5.1.1 Cable drums blocks 4.137.001

- low voltage measuring cable drum (4 cores), 25 m lenght
- drum with the power cable, 25 m lenght
- grounding cable drum (sectional view 25 square mm);
- drums with the high voltage testing screen DC cable up to 60kV and 25m length.

E. Electrical safety

6. Electro safety of the laboratory's crew support system

- Potential monitoring on chassis (switches off while higher than 24V potential appears)
- Grounding resistance monitoring (switches off while higher than 25Ohm resistance appears)
- Control of the high voltage compartment doors (switches off while the doors are open)
- Manual emergency switching
- Auto-forced grounding of the high voltage testing installations and testing objects connecting to them after the test finish and in the case of emergency;
- The installation of visual clearance of voltage falling
- Sound and light signal at the laboratory startup

F. Car – system power

7. The car system power is carried out by the external source of power 220V.

G. Laboratory's documentation

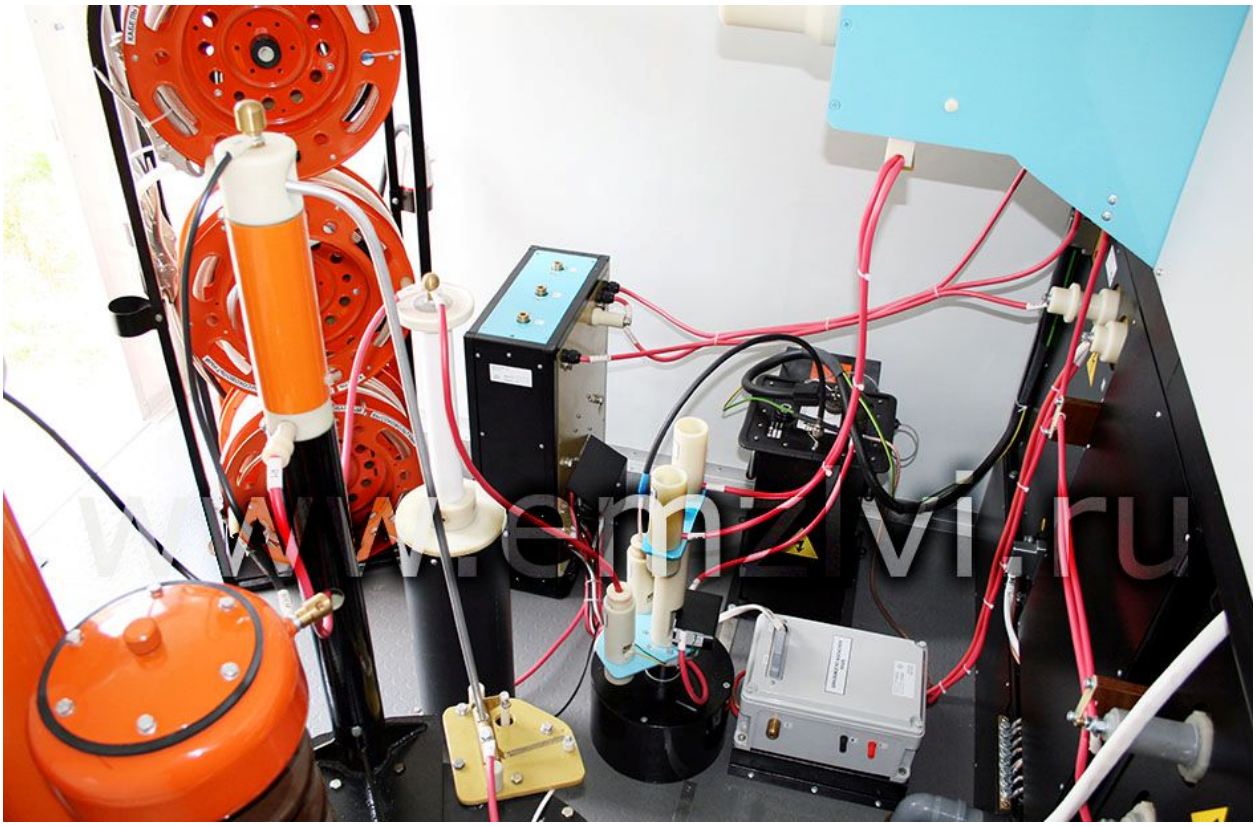
8.Operating documentation set (with the certificates of conformity to laboratory and units).

1.Operator's manual
2.Logbook
3.Electric schemes album
4.Program and methods of the laboratory periodical attestation

9. Chassis. AS a base auto Kamaz is being used. Kamaz provides the working ability of the laboratory not only in the municipal conditions but at broken ground as well due to its good cross-country ability.

10. Carbody. The isothermal van made from the sandwich-panels is established on the chassis. In the body of the car due to good thermal insulation the constant temperature is supported. The van is divided into two parts: high-voltage compartment and the operating compartment. An independent heater heats the van.

View on the control panel in the operator's section of the Cable mobile laboratory of LVI HVT series on Kamaz chassis



View on the high voltage section of the Cable mobile laboratory of LVI HVT series on Kamaz chassis

View on the instrumental cases of the Cable mobile laboratory of LVI HVT series on Kamaz chassis

The laboratory has the following main features:

- The equipment is build-in in the noise and heat-insulated carbody that helps to make comfortable working conditions of operator in cold and warm weather conditions.
- There is work table of Eurodesk type, makes the process of measurements and processing process easier.
- There is a special dividing wall between operator's and high voltage departments, which helps to prevent the touching of live parts.
- The special hatch is designed for the cable outlet to the object.
- The laboratory is equipped with the instrumental cases for the mounter's and driver's tools, it helps to raise the production standards, to make the working conditions better and more comfortable.
- The main equipment is set on the frame.
- Cable is laid in special cable channels.

I. Seminars of LVI HVT users

11. Training (seminar) for the customer's specialists

Quarterly on the «EMZ" holding company's territory the practical seminars for the technicians working with high voltage laboratories of LVI series are held.

We would like to suggest to the customer's specialists to get all the necessary knowledge about our LVI HVT laboratories, their main features and rules of safe operation. The seminars will help you to make a final decision about the desired laboratory.

The seminar program consists of:

1. Constructive design of LVI HVT laboratories of various updating and their components.
2. High-voltage tests of power objects and definition of insulation quality.
3. Methods of definition of power cable faultlocating.
4. Practical work with the laboratory's equipment on a test area.
5. Different set of additional devices and their operation for LVI HVT laboratories.
6. Car- bodies construction of LVI HVT laboratories, service of car-bodies, and the safety precautions requirements using the vehicles.
7. The organization of guarantee and post- warranty service.
8. Maintenance staff of LVI HVT protection stage.

Practical training

J. Service

The «EMZ» Holding Company pays undiverted attention to their production's technical user support. Our products bear the all-round guarantee program which includes the guarantee period of service and after - the guarantee period of service.

12.Warranty repair:

The warranty period of laboratory is 12 months. On the morrow of the warranty period the manufacturer carries out after warranty service of machinery if the customer desires it.

13.Post-warranty service:

The post-warranty service means that we consult the customers, put their laboratories to usual examination schedule, metrological maintenance, blocks' repair, repair of laboratory knots and overall laboratory. We can also suggest reconstructing and modernizing technically out-of-date laboratories.

Highly skilled experts quickly and qualitatively render all necessary assistance to our customers.

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